SCIENTIFIC BOOKS

Higher Mathematics for Chemical Students. By J. R. PARTINGTON. New York, D. Van Nostrand Co. 1912.

A first question is: Do chemists need any higher mathematics? And it must be admitted that the inorganic analytical chemist, the organic synthetic chemist, the agricultural chemist, and a host of others, by a large margin the majority of all, do not need much, if any, mathematics, and perhaps a quarter century ago no chemist was much the better off for a knowledge of the subject. Of late, however, there has been a great development of physical and dynamic chemistry, wherein mathematical methods are of great importance, so that there has come considerable demand for mathematics from a large and growing class of theoretical chemists, and the demand is likely to increase in the future. Indeed if a student desires to read such memoirs as that of Gibbs on the equilibrium of heterogeneous substances, he must have a tolerably thorough foundation in some branches of mathematics.

A second question: Is there any necessity for a special treatment of calculus for chemists? The appearance of such works as Mellor's "Higher Mathematics for Students of Chemistry and Physics" and this work of Partington's would seem to imply that there was. And the publication of special texts for engineers, economists and the like is evidence that others than chemists feel such a need. In this connection we may cite the excellent address by C. Runge at the International Congress of Mathematicians in Cambridge last summer on the university training of the physicist in mathematics. It is there pointed out with force, but kindness, that our mathematicians do not organize their course of instruction with sufficient reference to the advantages of the great majority of their students, namely, those who are going into physics, chemistry, economics, engineering, and, indeed, anything except pure mathematics—and in so organizing them they are not making for any very preponderating advantages for the few students of pure mathematics.

The sort of course in calculus that the elementary student of applied mathematics should have is one where the ideas and methods of differential and integral calculus, including differential equations, are most fully emphasized and thoroughly illustrated by simple formal work applied to a great variety of problems. For it must be remembered that nine tenths of the problems where the student will use his calculus can be treated with the simplest sort of analysis. So long as mathematicians insist upon a training in differentiation and integration which requires the exercise of a considerable amount of advanced algebra and analytical trigonometry, the student of the elementary applications will find himself burdened with unnecessary material which may be hard for him and which can not fail to distract his attention from the work he most needs. And just so long there will be attempts, justifiable attempts, to compile treatises out of the line of the regular mathematical courses for the use of such students.

Whenever a book thus intended for a special class appears it must be judged from a double point of view: First, how is it as mathematics; second, how does it meet the needs of that special class?

Judged from the point of view of the mathematician, Partington's work is far from good; it has that sort of inaccuracy which indicates that its author, no matter how much he may use his mathematics, does not have any thorough knowledge of the subject; it abounds in the kind of glaring crudities with which every serious teacher is familiar on the part of his pupils and which he seeks constantly to eliminate, though often unsuccessfully, from their minds. A few instances must be cited to justify so sweeping a condemnation.

On page 21 in the definition of limit the statement that the variable can never reach its limit is incorporated. With the artificial discontinuous variable of elementary geometry this is true, though unessential; with the continuous variables of physics it is not true. On page 31 in varying the equation $pv = K$ by assigning increments to the variables the author writes

$$(p + dp)(v - dv) = K.$$

Now $v - dv$ in place of $v + dv$ is just the sort of error we have constantly to warn the freshman against. The increment dv may be negative, but should not be written as $-dv$. The author finds the correct result $dp/dv = -p/v$ incorrectly from an incorrect equation. On page 67 there is this choice bit: "At this point (such as P) there is a sudden change of direction; it is therefore called a *point of inflection*." A fine definition! How could the author have made more errors in so short a sentence! On page 86 we find: "It must not be supposed, however, that the series obtained by differentiating a convergent series term by term is also convergent. Thus the series

$$1 + x^1 + x^{1\cdot 2} + x^{1\cdot 2\cdot 3} + x^{1\cdot 2\cdot 3\cdot 4} + \cdots$$

is convergent for $|x| < 1$, but the series

$$1 + 2x + 6x^5 + \cdots,$$

obtained by differentiation, is divergent for all values of x." Now if there is any one fact better known or more fundamental than that a power series which converges is differentiable term by term and yields a convergent series, we fail to know what it is. This sort of mistake can arise only when ignorance is blatant enough to talk about matters of which it is so completely ignorant that it does not even recognize its ignorance. No author can wholly avoid errors, but here they are too many and too gross for any charitable inference.

But this book is intended for chemists, and in justice it should be judged chiefly upon what it does for them, what it gives them that they need, what it spares them that for them would be superfluous. Here we must admit that we think the work a great success. To the mathematician, the physicist or the electrical engineer the total omission of all reference to the circular functions and their inverses would seem incomprehensible. But the chemist has no need of oscillating functions; his phenomena run one way. The restraint that the author has exhibited in leaving entirely aside the trigonometric functions is therefore highly commendable. Again, the author uses differentials in differentiating and gives a tolerably full account of partial differentiation, of the total or exact differential, and of circuit integrals. These matters are of great importance to the chemist. Moreover, though his work is chiefly elementary calculus, it somewhat justifies the more general title Higher Mathematics by the introduction of methods of interpolation, extrapolation, approximation formulas and the like, and it finds place on almost every page to appeal to the chemist by selecting exclusively for its applications problems which actually arise in that subject.

The titles of the chapters will give an idea of the scope of the text. Functions and limits, rate of change of a function, differentiation of algebraic functions, maximum and minimum values of a function, exponential and logarithmic functions, partial differentiation, interpolation and extrapolation, the indefinite integral (two chapters), definite integrals, application of the definite integral, differential equations (two chapters), and appendices containing the theory of quadratic equations, the solutions of systems of linear equations by determinants, approximation formulas, and a tabulation of the exponential and natural logarithmic functions. As has been stated, everywhere are found detailed and vital applications to chemistry, to which the list of entries in the index bears ample witness. The student who masters the text will do so with the fullest appreciation of its use to him and will attain a knowledge sufficient for most of his needs, albeit if he wishes to read such highly mathematical works as Gibbs's papers he must pursue his studies somewhat further. For the class for whom it is designed the book is far more useful than the ordinary text on calculus.

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The appearance of a fourth edition of this